

MEBT & RT CH Section

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**Fermilab Accelerator Advisory Committee
May 10th – 12th, 2006**

Outline

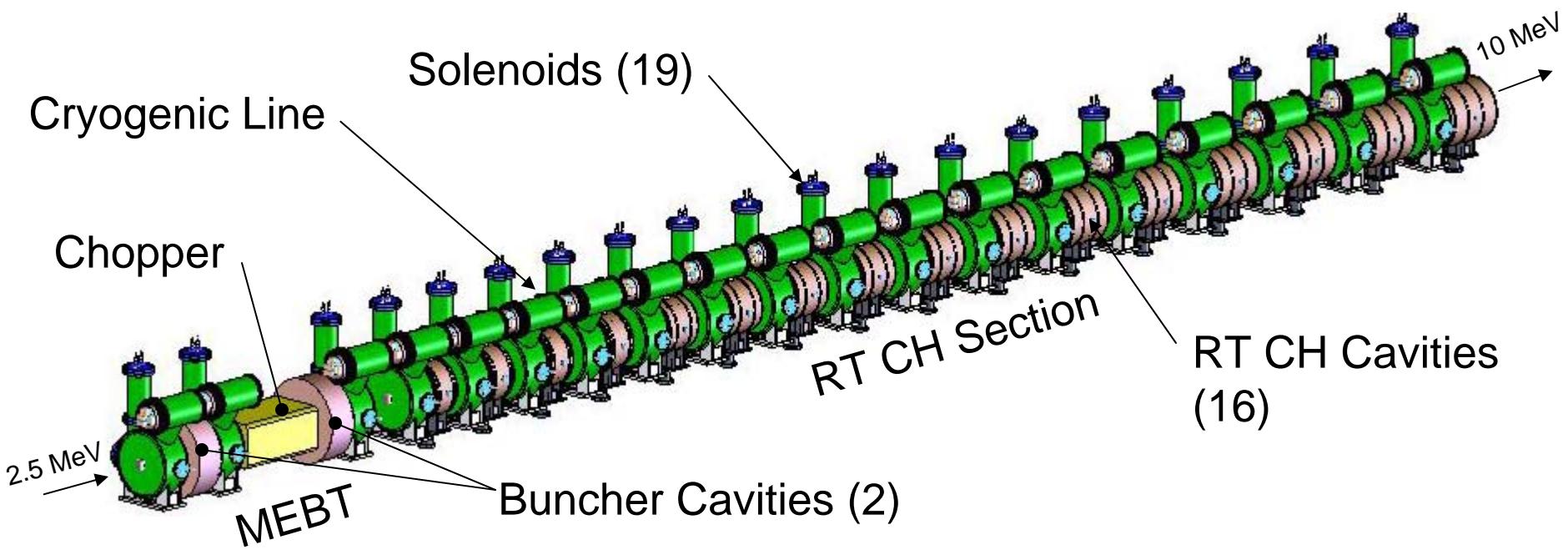
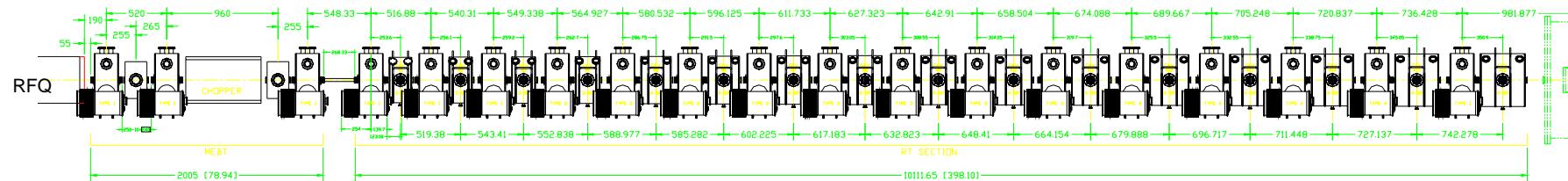
- **Introduction**
- **MEBT & RT CH Section Layout**
- **MEBT Components**
 - Buncher cavities
 - Chopper
- **RT CH cavities**
- **MEBT / RT CH Section solenoid cryostats**
- **MEBT / RT CH Section solenoid magnets**
- **Conclusion**

Introduction

- **MEBT details**
 - 3 superconducting solenoid magnets.
 - 2 buncher cavities.
 - 1 chopper.
 - 2.5 MeV input energy from RFQ.
- **RT CH Section details**
 - 16 superconducting solenoid magnets.
 - 16 room temperature copper spoke resonators.
 - 10 MeV output energy to SSR Section.
- **Solenoids in MEBT and RT CH Sections are identical.**

MEBT & RT CH Sections

Top View



MEBT Components

- **Buncher cavities (2)**

- Original plan to use 1st spoke cavity for buncher. The idea was the cavity would use less power and be more compact than an omega type cavity. After analysis, it was determined that the spoke cavity would be approximately the same size and use more power (lower shunt impedance). It was decided to use the omega type cavity for the buncher (used at SNS & J-PARC).
- MoU with LBL to design buncher cavities, Dec. 2006.
- Procurement will take place in 2007.

- **Chopper**

- Linac Bunches spaced **325 MHz (3.1ns)**.
- In MI, bunch spacing is **~53 MHz (~19ns)**.
- Chop out ~1 of every 6 bunches
- Additional complication: $325 \neq n \cdot 53$
 - \Rightarrow Sometimes chop 1, sometimes 2
- Only 3 ns between bunches: use a traveling wave type deflector.



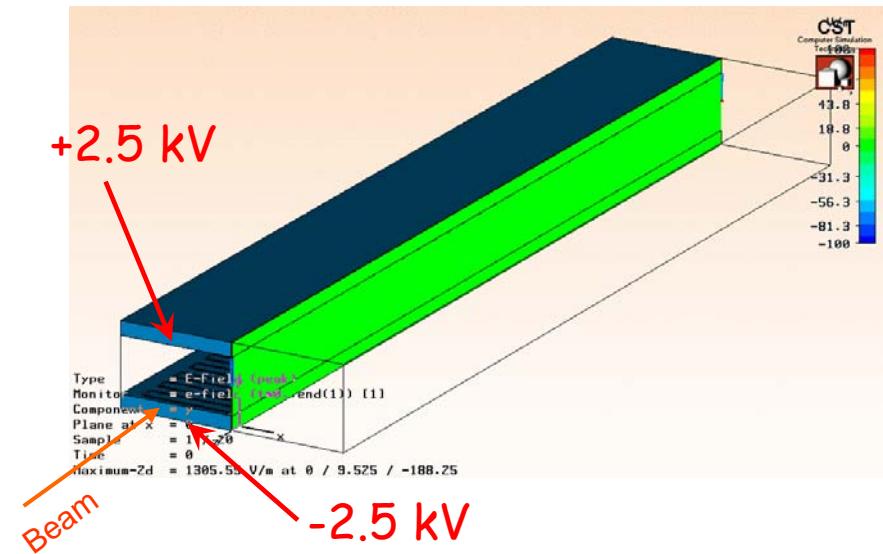
JHF Buncher

MEBT Chopper (cont.)

- Since $\beta=0.073$ @ 2.5 MeV, need to slow down pulse => use meander type deflecting structure.
 - Distance between structures = 16 mm
 - Meander length = 50 cm
 - Deflection = 6 mm
 - Need $V = \pm 2.5$ kV (coverage factor ~ 0.75)



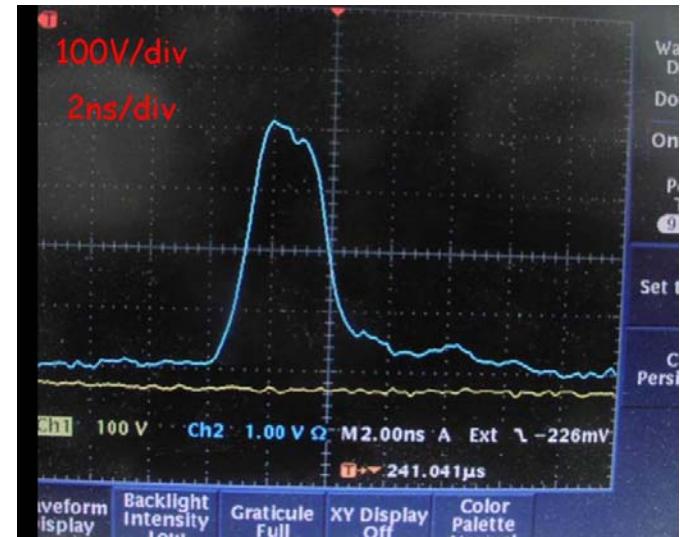
Prototype meander
courtesy Fritz Caspers, CERN.



Model of meander structure.

MEBT Chopper Pulser

- **Pulser prototype built at Kentech.**
 - 500V into 50 ohms with a rep rate of 53 MHz.
 - Initial problems limited tests to 400V, this has been fixed and is now operating at 500V.
 - Fermilab personnel visiting this month and will discuss possibilities for achieving 2.5kV.
- **Fermilab is working in parallel on a pulser design.**



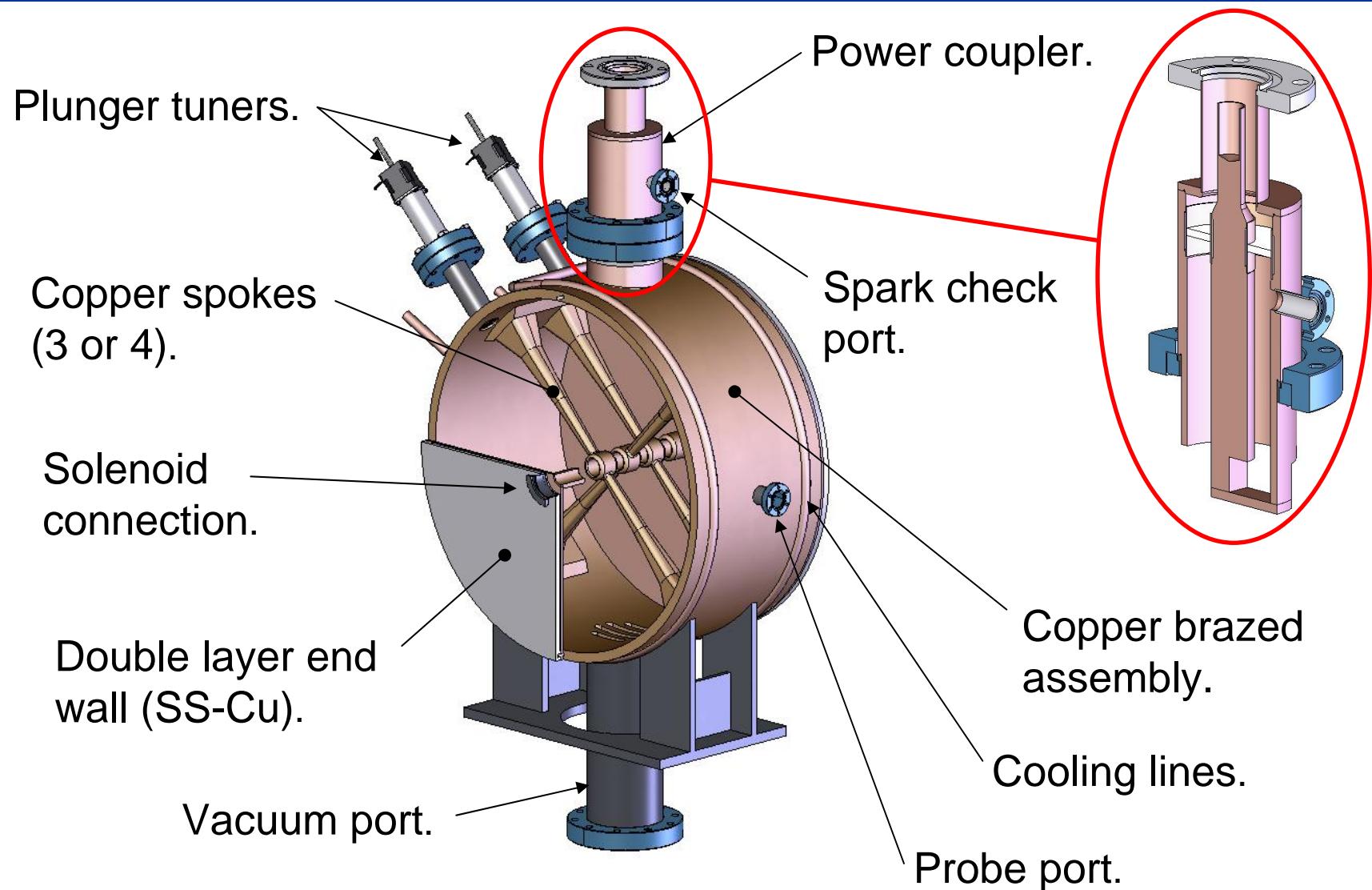
400V pulse at Kentech.

RT CH Cavities

- RT CH => Room Temperature Cross Bar H-type
- CH type cavity used instead of DTL
 - Impedance of CH type 2X larger than DTL => one-half the power req.

Cavity number	Beta of cavity	Rsh MOhm	Q	Voltage eff MV	Phi_s degrees	W kin MeV out	dW MeV	Pcopper kW	Pbeam kW I=26 mA	Ptotal kW
0						2.50639				
1	0.07437	5.196	9270	0.233107	-46	2.66832	0.16193	5.228931	4.21018	9.439111
2	0.077096	5.45	9662	0.305553	-42	2.89542	0.2271	8.56537	5.9046	14.46997
3	0.080441	5.65	10051	0.367743	-43	3.16443	0.26901	11.96767	6.99426	18.96193
4	0.084211	5.792	10461	0.425032	-42	3.48036	0.31593	15.59494	8.21418	23.80912
5	0.088233	8.617	10772	0.434359	-39	3.81798	0.33762	10.94739	8.77812	19.72551
6	0.09235	9.02	11078	0.46784	-39	4.18166	0.36368	12.13272	9.45568	21.5884
7	0.096797	9.41	11374	0.526789	-35	4.61328	0.43162	14.74529	11.22212	25.96741
8	0.101528	9.766	11680	0.570348	-37	5.06887	0.45559	16.65455	11.84534	28.49989
9	0.106271	10.12	11945	0.582932	-35	5.54653	0.47766	16.78902	12.41916	29.20818
10	0.111067	10.45	12220	0.609035	-33	6.05746	0.51093	17.74756	13.28418	31.03174
11	0.115949	10.737	12465	0.632117	-31	6.5994	0.54194	18.60724	14.09044	32.69768
12	0.120984	11.04	12750	0.685361	-30	7.19307	0.59367	21.27353	15.43542	36.70895
13	0.126222	11.31	13005	0.740279	-30	7.83439	0.64132	24.22689	16.67432	40.90121
14	0.131596	11.584	13271	0.787771	-30	8.51682	0.68243	26.78624	17.74318	44.52942
15	0.137085	11.79	13494	0.842331	-30	9.24653	0.72971	30.08997	18.97246	49.06243
16	0.142159	11.977	13723	0.818503	-40	9.87382	0.62729	27.9681	16.30954	44.27764
								280 kW	192 kW	471 kW

RT CH Cavity Details



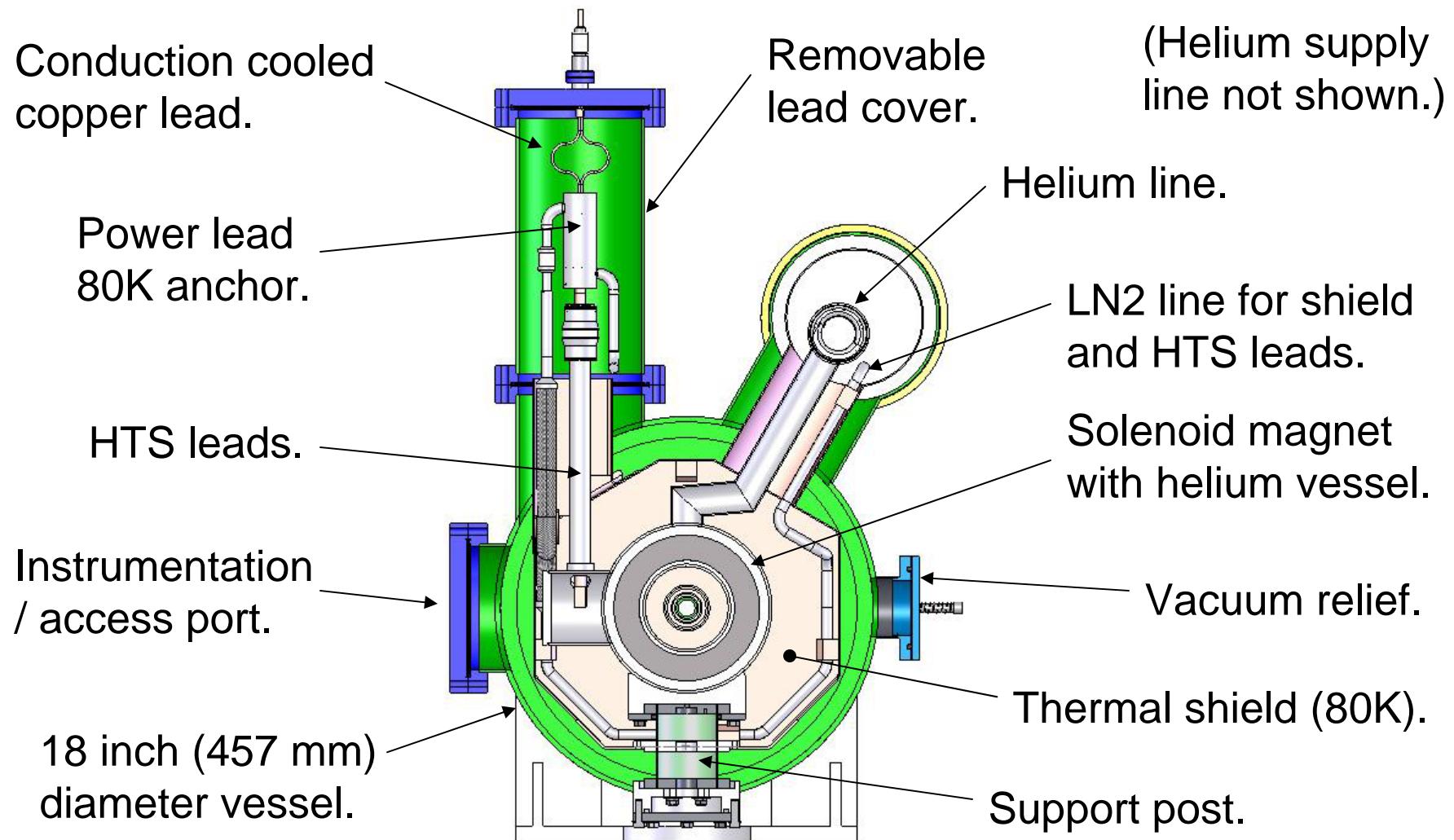
RT CH Cavity Schedule

- June 2006: First prototype available.
- August 2006: Power coupler & tuners available.
- September 2006: Test of fully dressed prototype.
- End of 2007: All 16 cavities available.

	Sep-05	Oct-05	Nov-05	Dec-05	Jan-06	Feb-06	Mar-06	Apr-06	May-06	Jun-06	Jul-06	Aug-06	Sep-06	Oct-06	Nov-06	Dec-06	Jan-07	Feb-07	Mar-07	Apr-07	May-07	Jun-07	Jul-07	Aug-07	Sep-07	Oct-07	Nov-07	Dec-07	Jan-08
RTCH #1	Design		Release		Procurement		Test																						
Input Coupler				D	R	P						T																	
Tuning system				D	R	P					T																		
RTCH #16				D		R	P						T																
RTCH #2						D	R		P								T												
RTCH #3						D	R		P								T												
RTCH #4						D	R		P								T												
RTCH #5						D		R		P							T												
RTCH #6						D		R		P							T												
RTCH #7						D		R		P							T												
RTCH #8						D		R		P							T												
RTCH #9						D		R		P							T												
RTCH #10						D		R		P							T												
RTCH #11								D		R		P					T												
RTCH #12								D		R		P					T												
RTCH #13								D		R		P					T												
RTCH #14								D		R		P					T												
RTCH #15								D		R		P					T												

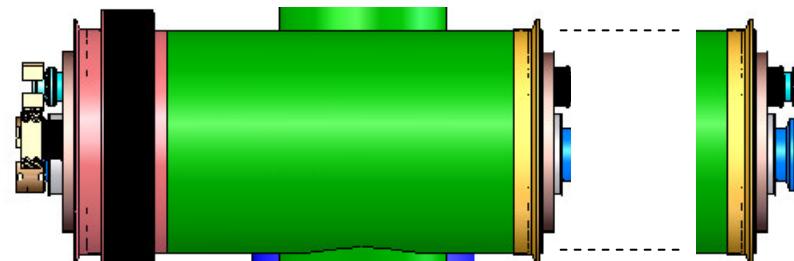


MEBT/ RT CH Solenoid Cryostat

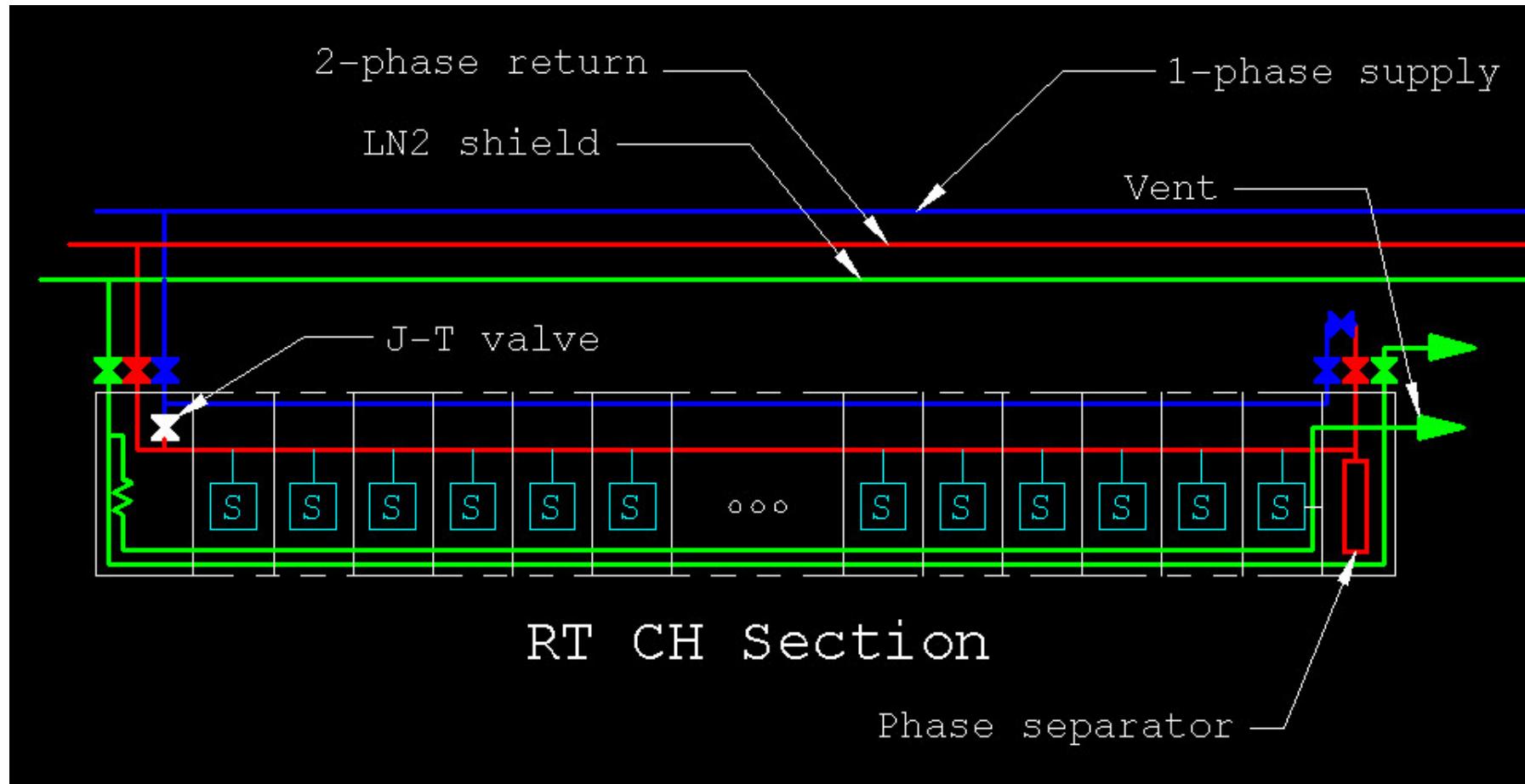


MEBT / RT CH Sol. Cryostat Types

- **4 types of solenoid cryostats due to the increase in focusing period length along the linac.
(downstream end of cryogenic line gets longer)**
 - Type 1: 3 MEBT; Sol.# 1, 2, 3 & 16; total = 7
 - Type 2: Sol.# 4, 5, 6 & 7; total = 4
 - Type 3: Sol.# 8, 9, 10 & 11; total = 4
 - Type 4: Sol.# 12, 13, 14 & 15 ; total = 4
 - **Total: 19 installed + 1 spare of each type = 23**
- **Each type has a set range of center-to-center install lengths. Range for each type: 50 mm.**
 - Example: Type 1 install range from 500 – 550 mm center-to-center-spacing.



MEBT / RT CH Section Cryogenics



Solenoid Magnets (All)

	MEBT / RT CH	SSR-1	SSR-2
# of solenoids in section	19 (3 + 16)	18 (9 x 2)	12 (6 x 2)
Cryostat type	Stand alone	Integrated in SSR cryostat	Integrated in SSR cryostat
Bore Diameter [mm]	20	30	30
Bore type	Warm	Cold	Cold
Field Integral FI= $\int B^2 dl$ (T ² ·cm)	180 – 200	300	580

- **Test coils PDST-02 and PDST-03: May, 2006.**
- **MEBT / RT CH Section solenoid**
 - Prototype complete and tested in the vertical Dewar: September, 2006.
 - Prototype tested in a horizontal cryostat: end of the year, 2006.
- **SSR Section solenoids**
 - Design and development start May, 2006.
 - First prototype tests early in 2007.

MEBT / RT CH Sol. Cryostat Schedule

	Jan 06	Apr 06	Jul 06	Oct 06	Jan 07	Apr 07	Jul 07	Oct 07	Jan 08	Apr 08	Jul 08	Oct 08	Jan 09	Apr 09	Jul 09	Oct 09
HTS Leads																
Design																
Prototype																
Production																
Solenoid Magnets																
Design			RT CH		SSR											
Procurement					RTCH		SSR									
RT CH Sol. Fabrication								SSR								
RT CH Sol. Test									SSR							
SSR Sol. Fabrication										RT CH						
SSR Sol. Test											RT CH					
Solenoid Cryostats																
Design																
Prototype and Test*																
Production Procurement																
Fabrication / Installation																

* Cost and schedule permitting.



Conclusions

- **MEBT Components**
 - Buncher cavities: MoU with LBL in place for buncher cavity design.
 - Chopper
 - Design and analysis in progress.
 - More R&D needed on pulser.
- **RT CH Cavities**
 - EM designs for all 16 cavities are complete.
 - First prototype on order, coupler drawings soon to be released.
 - Mechanical design of highest power cavity (#16) in progress.
- **MEBT / RT CH Solenoids**
 - Coil prototyping in progress, first coil tests confirm design.
 - Cryostat conceptual design nearly complete, detail drawings soon.
 - Starting discussions with vendor on prototype HTS leads.

Acknowledgments

- **Buncher cavity**
 - Ivan Gonin
- **Chopper design**
 - Gennady Romanov, Robyn Madrak
- **RT CH Cavity design**
 - Gennady Romanov, Leonardo Ristori, Lee Simmons
- **Solenoid magnet design**
 - Iouri Terechkine, Tom Wokas, Gerry Davis
- **Many others not mentioned....**